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C-51-8-5-126

August 28, 1995

Project Number 2753

Mr. Charles Root (3HW21)
United States Environmental Protection Agency
841 Chestnut Street
Philadelphia, Pennsylvania 19107-4431

Reference: ARCS III Program
EPA Contract No. 68-W8-0037

Subject: Groundwater Extraction System Calculations
EPA Work Assignment No. 37-18-3L2S
AIW Frank/Mid-County Mustang Site
Remedial Investigation/Feasibility Study (RI/FS)

Dear Mr. Root:

As requested, Halliburton NUS Corporation (HNUS) has reviewed the groundwater extraction system design as presented in the FS report for the subject site. The conceptual design discussed below is intended to contain the contaminant plume and to reduce the size of the plume over time. The approach taken involves installing wells along the centerline axis of the plume, beginning in the source area on site and extending to a point slightly west of North Ship Road in the downgradient direction. The composite trichloroethylene (TCE) plume extent (greater than 1 ug/l) shown in Figure 4-21 of the final RI report (HNUS, 1995) was used as the basis for determining the extent of groundwater contamination requiring cleanup. The actual extent of contamination may be more or less than this estimate, given the available information and the final groundwater clean-up levels specified in the Record of Decision (ROD) for this site.

The conceptual design includes a total of six wells pumping at 23 gallons per minute (gpm) each, for a total extraction rate of 138 gpm. The attachment to this letter provides the back-up calculations for the conceptual design. Well spacings are closest within the site area, expanding with increasing distance from the site. This varied spacing was used to focus groundwater extraction efforts within the most impacted part of the plume, while still providing adequate coverage of the downgradient area. This well configuration will allow for the shutdown of extraction wells in areas where clean-up standards are achieved more quickly than in other areas, without compromising the operation and effectiveness of those wells that will continue to pump for longer time periods. The design is intended to pull the limits of the plume in both laterally and back toward the site over time.

This design is conceptual in nature, due primarily to limitations with regard to aquifer characteristics and contaminant distribution data. For a detailed design, additional field and hydrogeologic tests would be required to better establish the limits of contamination laterally and vertically and the hydraulic characteristics of the impacted aquifer. In addition, due to the inherent wide variations in hydraulic

AR303251



C-51-8-5-126
Mr. Charles Root (3HW21)
United States Environmental Protection Agency
August 28, 1995 - Page 2

characteristics of fractured and karst aquifers, additional design/operation modifications would be needed during the implementation phase of a pump and treat remedy at the site.

Please contact me if you have any questions or comments.

Sincerely,

Neil Teamerson

Neil Teamerson
Project Manager

ANT/vb

Attachment

c: Joseph Tralie (EPA Region III) (without enclosure)
Garth Glenn (Halliburton NUS)
Paul Persing (Halliburton NUS)

AR303252

CLIENT USEPA		JOB NUMBER 2753, 1251	
SUBJECT AIW Frank Site FS			
BASED ON		DRAWING NUMBER	
BY JPO	CHECKED BY Tea	APPROVED BY Tea	DATE 25 Aug 95

Purpose - Develop conceptual gw remediation design for AIW Frank Site. Based on plume location and gw flow maps, design system to contain & remediate gw at and downgradient of the site. Position wells along the centerline of the plume, beginning in the source area. More rigorous analysis required for detailed design.

Assumptions - Thickness of gw plume ~ 175'
 - Hydraulic conductivity of bedrock aquifer (average) ~ 5 ft/day (K)
 - Average gw flow gradient ~ .015 (i)
 - Storativity (S) of bedrock aquifer ~ .001
 - Areal extent of gw plume defined by Figure 4-21 of the Final RE Report
 - Maximum width ~ 2000'
 - Design system to contain gw

Groundwater Flow - thru Rate

$$Q = K \cdot A$$

$$= 26,250 \text{ ft}^3/\text{day} \quad \checkmark$$

$$= 136 \text{ gpm} \quad \checkmark$$

$$A = 2000' \text{ wide} \times 175' \text{ thick}$$

- Need to pump @ 136 gpm to contain the plume.

Sustainable per-well pumping rate - Calculate estimated average long term Q based on assumed parameters, compare w/ reported average yields for local wells. Use most conservative (lowest) pumping rate for design purposes.

AR303253

CLIENT USEPA		JOB NUMBER 2753.1251	
SUBJECT AIW Frank Site FS			
BASED ON		DRAWING NUMBER	
BY JPO	CHECKED BY LEA	APPROVED BY LEA	DATE 25 Aug 95

- Assume steady-state drawdown reached within
30 days = t

- Assume max allowable drawdown $\approx 10\%$ of aquifer
(plume) thickness = $175/10 \approx 17' = S$ ✓

$$S = \frac{2.3Q}{4\pi T} \log \frac{2.25 T t}{r^2 S}, \quad Q = \text{Pumping Rate}$$

$$T = 175' \times 5' / \text{day} =$$

$$875 \text{ ft}^2 / \text{day}$$

$$t = 30 \text{ days}$$

$$S = .001$$

$$r = \text{well radius} = 0.25'$$

$$S = 17'$$

$$Q = \frac{4\pi T S}{2.3} \log \frac{2.25 T t}{r^2 S}$$

$$= 81,272 / 8.98 \quad \checkmark$$

$$= 9050 \text{ ft}^3 / \text{day} = 47 \text{ gpm} \quad \checkmark$$

From RI report, median well yields in the Conestoga Limestone, Ledger Dolomite, and Elbrook Ftn are about 25-30 gpm - Use 25 gpm/well for design purposes.

Number of Wells required = Total Q / per-well pumping rate

$$= 136 \text{ gpm} / 25 \text{ gpm per well}$$

$$= 5.4 \text{ wells, assume 6 wells @ 23 gpm each.} \quad \checkmark$$

Capture zone widths for each well, maximum (upgradient) and at the well location

$$C_{2\text{max}} = Q / Kib, \quad Q = 23 \text{ gpm} = 4428 \text{ ft}^3 / \text{day}$$

$$= 4428 / (5 \text{ ft/day}) (0.015) (175')$$

$$= 337 \text{ ft maximum, } 1/2 \text{ the max at the location of the pumping well} = 168' \quad \checkmark$$

AR303254

CLIENT USEPA		JOB NUMBER 2753.1251	
SUBJECT AIW Frank Site			
BASED ON		DRAWING NUMBER	
BY JPO	CHECKED BY TGA	APPROVED BY TGA	DATE 25 Aug 95

Extraction Well Locations

- Install wells along centerline of plume, beginning in source area and extending to near the 1 ug/L line. Space wells more closely near the source area to focus remedial efforts. Increase spacing in downgradient area where plume concentrations are much lower. Assuming that overall groundwater flow direction mimics plume migration direction, pumping well capture zones will overlap & encompass most of the > 1 ug/L plume. Install/pump 6 wells @ 23 gpm each, total Q = 138 gpm. For conceptual well locations, see attached Figure.

Actual pumping rates & capture zone limits will vary from those shown. Adjustments to the conceptual design will be needed in the detailed design phase and during actual construction & operation of the system.

Additional Drawdown Due to Well Interference effects =

calculate DD @ pumping well & use attached graph to predict dd effects from other wells based on conceptual locations

Revised DD @ pumping well, for Q = 23 gpm (4428 ft³/day)

$$s = \frac{2.3Q}{4\pi T} \log \frac{2.25 T t}{r^2 S}, \quad Q = 4428 \text{ ft}^3/\text{day}$$

= 8.3' ✓ Other parameters as previously defined

For extraction well #3 (well w/ most well interference effects)

$$\text{Drawdown} = 8.3' + 2.3' (\text{from well \#1}) + 2.1' (\text{from well \#2}) + 2' (\text{from well \#4}) + 1.4' (\text{from well \#5}) + 1' (\text{from well \#6})$$

AR303255

AR303255

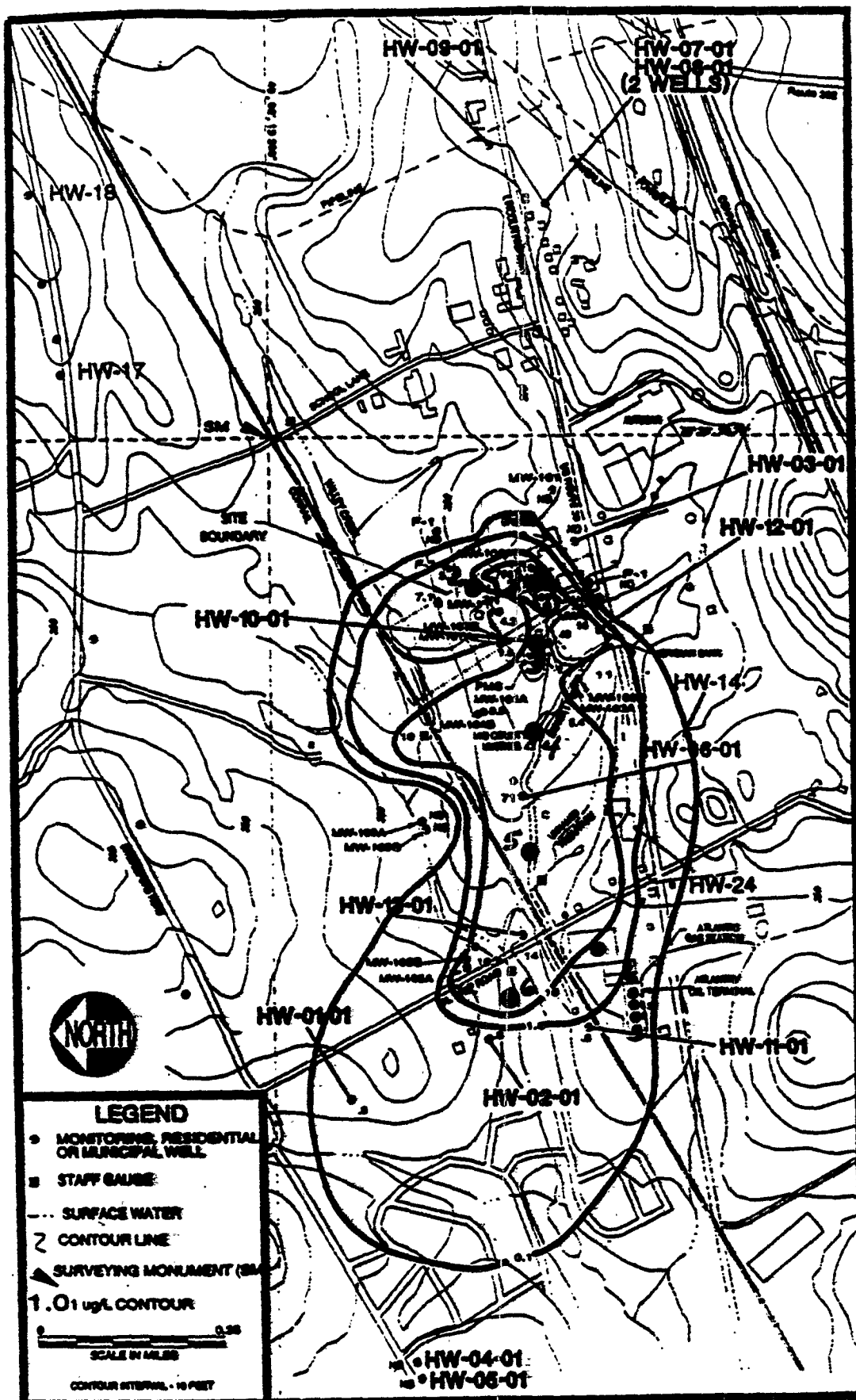
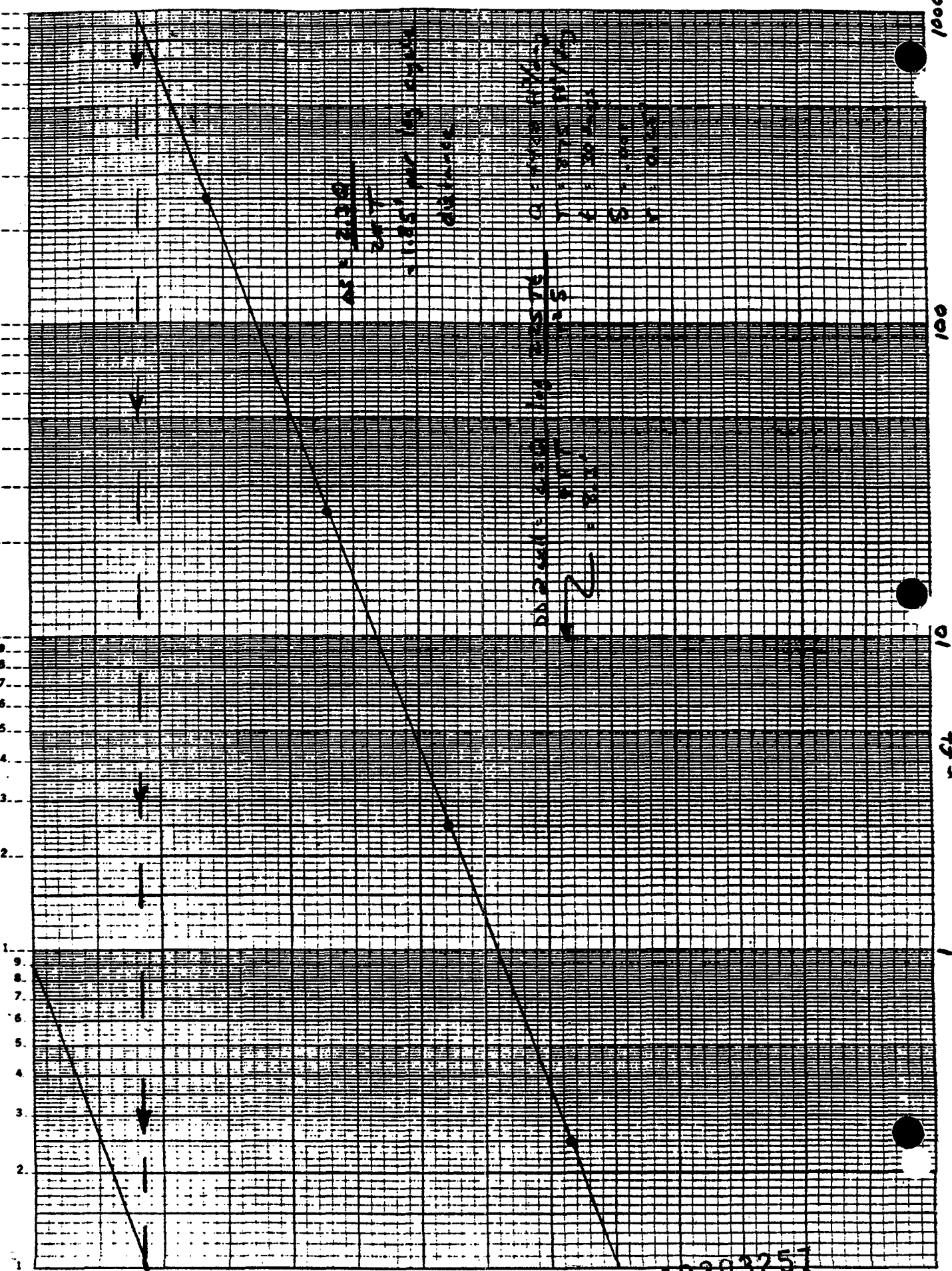


Figure 4.21 Composite Concentrations ($\mu\text{g/L}$) of TCE

Distance/Drainage Proportion for $Q = 2390$



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